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**Anger and Approach Motivation in the Parenting Context
and Associated Frontal Activity: An EEG Study**

A Dissertation Presented

by

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Abstract of the Dissertation

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Emotion processing in the brain produces asymmetrical cortical activity in the left and right prefrontal regions, dependent on the emotional stimuli used. Empirically supported but competing hypotheses explain this phenomenon using qualities of the emotion that characterize either its valence (positive or negative) or its motivation potential (approach or avoid). The emotional stimuli used are often confounded in that both positive affect and approach-oriented emotions have been positively associated with increased left prefrontal activity, and negative affect and avoidance-oriented emotions have been positively associated with increased right prefrontal activity. Anger, which is negative in valence and approach-oriented, disentangles previous confounds and positively relates to left frontal activity, supporting the motivation hypothesis of prefrontal asymmetry in emotion processing. This body of research was extended to the parenting context to test whether left frontal asymmetry is associated with anger and

interpersonal aggression. Forty mothers of children 2-4 years of age completed measures of anger, parental discipline, and an analog-parenting task while EEG data was recorded. Based on data linking greater left frontal cortical activity and approach-oriented motivation, it was hypothesized that (1) greater dispositional anger, and harsh discipline style in mothers would be positively related to greater left frontal activity at baseline; (2) greater dispositional anger would predict greater state related left frontal activity in the analog parenting task; (2a) harsher discipline styles would account for unique variance in state related left frontal activity; and (3) greater left frontal activity at baseline would predict greater reported anger and more harsh discipline responses from mothers following the misbehavior video. Partial support was found for these hypotheses. Trait anger is an important aspect of harsh overreactive discipline and was related to greater activation in the left frontal area of the brain during an anger evoking parenting context. No relationship was found between resting frontal asymmetrical activity and the other study variables. These findings may be translated into specific risk models or differential intervention approaches for parents with motivation sensitivity struggling with maladaptive discipline responses.

Dedication Page

To all who strive to answer questions to better the lives of others.

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Chapter 1

Emotions play an integral role in motivating the many behaviors and attitudes involved in parenting, yet are underexplored in parenting research (Dix, 1991). For example, anger in parents is likely an important aspect of maladaptive harsh discipline (e.g., Dix, 1991; Slep & O'Leary, 2007). Theories such as Baumrind's (1971) delineation of parenting styles (e.g., authoritarian style; Dix & Grusec, 1985) and Patterson's (1982) coercive family process model place anger-inflected behaviors at the core of maladaptive parenting and discipline. Etiological perspectives on child abuse speculate about the role anger and feelings of low control in the abusive parent (e.g., Bugental, Blue, & Cruzcosa, 1989). In clinical work with aggressive parents, one of the treatment goals is to reduce the likelihood that parents will discipline their children when angry (e.g., Sanders, 1999). For example, Parent Child Interaction Therapy (PCIT; Chaffin et al., 2004) attempts to increase positive interactions between parents and children, and create a consistent discipline routine that reduces the amount of time parents and children spend in conflict with one another, and it circumvents angry parenting. However, these theories and interventions do not directly address the mechanisms linking anger to harsh discipline in the first place, because they are still not well understood.

Advances in affective neuroscience have now made it possible to directly study some of the mechanisms linking emotions such as parental anger and behaviors such as harsh parental discipline. Alpha activity in the frontal area of the brain has been implicated in differential emotion processing (e.g., Davidson & Fox, 1989; Tomarken, Wheeler, Davidson, & Doss, 1992). For example, greater right frontal asymmetry in alpha activity when EEG is recorded at rest and with evocative stimuli have been linked to experienced sadness, depression, fear, and less consistently anxiety (e.g., Davidson & Fox, 1989; Tomarken et al., 1992). Greater left frontal

asymmetry has been linked to happiness, positive contentment, and more recently anger (e.g., Harmon-Jones & Allen, 1997; Wheeler, Davidson, & Tomarken, 1993). In addition, asymmetry in the left and right frontal hemispheres has been differentially associated with more approach (i.e., aggression) and avoidant (i.e., withdrawal, inhibition) behaviors in response to emotion evoking stimuli (e.g., Coan & Allen, 2004; Davidson, 1993; Harmon-Jones et al., 1997). Multiple theories have been advanced to explain these relationships (e.g., Davidson, 1993; Harmon-Jones, 2003; Heller, 1990). This study will test the motivational theory (e.g., Davidson, 1993) of frontal asymmetry and emotion processing with anger in the parenting context of discipline. The extension of this work to an interpersonally relevant context such as parenting will broaden the scope and applicability of the motivational theory of emotion processing to more applied settings. Further, if individual differences in the degree of parental anger and aggressiveness can be identified with differential brain activity, this information may be translated into more specific risk models or differential intervention approaches for approach sensitive parents struggling with maladaptive discipline responses.

Theories about the characteristics of emotion that belie frontal asymmetry in emotion processing are reviewed first. Then, evidence specific to anger in differential frontal activity are reviewed and its expansion to the context of parent child interactions is justified. The primary aims of this study were to further expand our understanding of parenting by applying an affective neuroscience approach, and to expand understanding of emotion processing to a highly generalizable context using the experience of anger in parenting.

Theories of emotion processing and frontal asymmetry

Asymmetrical electrical activity in the prefrontal cortex (PFC) has been associated with both the valence (e.g., Heller, 1990) and motivation (e.g., Davidson, 1993) of emotional stimuli.

The affective-valence hypothesis posits that demonstrated asymmetrical activity in the frontal region of the brain at rest and in response to emotion elicitors follows the positive and negative valence of various emotions (e.g., Heller, 1990). For example, greater right frontal activity at rest predicted greater negative affect to negative film clips (Tomarken, Davidson, & Henriques, 1990). In parallel, greater left, relative to right frontal cortical activity in resting EEG recordings predicted more positive affect to positive film clips (Wheeler, Davidson, & Tomarken, 1993). Increased cortical activity in the right, relative to the left frontal area at rest, has been used to predict infant crying during maternal separation (Davidson & Fox, 1989).

The motivational direction hypothesis — similar to Gray's (1987) model of behavioral activation and inhibition systems (BAS/BIS) — posits that increased left frontal activity should be related to the behavioral activation system (BAS), which is sensitive to conditioned reward, and escape from punishment and engenders actions toward one's goals (e.g., Carver & White, 1994; Davidson, 1993; Harmon-Jones & Allen, 1997). Increased right frontal activity as well as reduced left prefrontal activity should be related to the behavioral inhibition system (BIS), which is sensitive to innate fear and conditioned punishment or nonreward (Carver, 2004; Carver et al., 1994; Harmon-Jones et al., 1997). Indeed, a substantial body of research found left frontal asymmetry in resting EEG recordings related positively to approach related tendencies and greater BAS sensitivity (e.g., Fox & Davidson, 1984; Harmon-Jones & Allen, 1997). However, frontal asymmetries do not consistently relate to BIS sensitivity (e.g., Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). Other aspects of behavioral and emotional withdrawal such as fear responses and depression do significantly relate to increased right frontal cortical activity (Davidson, 1993; Henriques & Davidson, 1990).

Valence and motivational direction are confounded in many of the studies discussed

above by virtue of the emotional stimuli used (Harmon Jones & Allen, 1998). Positive emotions are generally associated with movement toward a goal or salient stimulus (approach), and negative emotions are generally associated with avoidance of an aversive stimulus (withdrawal). Harmon-Jones (2003; Harmon-Jones et al., 1998) hypothesized that demonstrated frontal-asymmetries in cortical activity are related to the motivational properties of experienced emotions independent from their positive or negative valence. To test this hypothesis, an emotion discordant in its valence and motivational properties was needed. Anger, defined as an emotion that arises when goals or expected outcomes are blocked (e.g., Berkowitz, 1993), meets these requirements.

First, anger is categorized as a negative emotion not only semantically, but also theoretically and subjectively. (e.g., Huebner & Izard, 1988; Tomkins, 1968). Emotion theories such as the circumplex model of affect categorize discrete emotions along two dimensions: valence and activation (Russell, 1980). Anger falls in the negative valence, high activation quadrant (Russell, 1980). Subjectively, people describe it as a negative (i.e. stressful) subjective experience (Lazarus, 1999) and have an unfavorable attitude toward it (Harmon-Jones, 2000). Universally, people can discriminate it among facial expressions (Ekman & Friesen, 1971). In addition, anger is associated with negative long-term consequences; it may be socially disruptive and could negatively impact health if maintained for prolonged periods. For example, a longitudinal study of school children using peer nominations found that children were more likely to be classified as socially rejected if they showed more anger than other children (Dodge, Lansford, Salzer-Burks, Bates, Pettit, et al., 2003). Results of a prospective study of the health effects of anger found that greater anger at baseline predicted increased incidences of both fatal and nonfatal coronary heart disease over the following seven years in older men (Kawachi,

Sparrow, Spiro, Vokonas, & Weiss, 1996).

Second, anger appears to motivate approach behavior tendencies aimed at removing obstacles to goals and desired outcomes (e.g., Berkowitz, 1962). For example, infants who displayed greater anger in response to extinction trials also had better persistence in relearning trials, compared with infants who were not angered (e.g., Lewis, Sullivan, Ramsay, & Alessandri, 1992). Experimental animal models of aggression have demonstrated that mice will cross an electrified grid to attack another mouse when anger is elicited (Lagerspetz, 1969). In humans, couples that report greater or more frequent anger also engaged in more interpersonal conflict and increased aggression (Margolin, John, & Gliberman, 1988; O'Leary & Vivian, 1990). The anger response also implies perceived controllability over the outcome (Lewis & Ramsay, 2005).

In sum, anger signals to the individual that things are not going as wished, it motivates actions to rectify the situation, and it can potentiate approach (e.g., aggressive) behavior to achieve this goal. These characteristics make anger a useful emotion to help disentangle the confounded valence and motivation hypotheses of frontal asymmetry. A series of studies by Harmon-Jones have used anger as a trait and state dependent stimulus to test the motivation hypotheses of frontal asymmetry; the following is a review of his evidence.

Trait anger and approach related frontal asymmetry

Trait measures of emotion assess the tendency of an individual to experience and express a particular emotion across situations. Harmon-Jones and Allen (1998) found that trait anger was positively related to resting left frontal cortical activity and negatively related to resting right frontal activity in school children and adolescent psychiatric inpatients. In addition, they found that neither trait positive nor negative affect was significantly related to frontal asymmetries.

Given the positive association between resting left frontal activity and trait anger, the association between BAS and trait anger should be positively related as well, despite its negative affective valence. Indeed — BAS was positively correlated with trait anger despite the concentration of positive affect items on the BAS questionnaire (Harmon-Jones, 2003). Further, physical aggression was associated with BAS in this study.

Manipulating anger in a situation to see its effects on frontal asymmetry would speak to a causal role between emotion and frontal asymmetry that is motivation driven rather than valence driven. To test this hypothesis experimentally, Harmon-Jones and Sigelman (2001), assigned college students to either an insult or no insult condition (i.e., another student critiqued a personally relevant essay negatively or in a neutral way) prior to recording EEG activity. As predicted, they found that students who were insulted showed greater activation in the left, compared with right, frontal region immediately following the insulting feedback. Further, insulted students also behaved more aggressively toward the confederate student who insulted them, compared with those that received neutral feedback. Aggression was measured by the student's choice of a sweet or sour liquid for the confederate to ingest (Harmon-Jones & Sigelman, 2001).

As reviewed above, laboratory manipulations of anger and trait anger are reliably associated with greater left relative to right frontal cortical activity. Study participants often have increases in self-reported anger following laboratory inductions of anger or goal-blockage (e.g., Harmon-Jones et al., 2003). In addition, aggression or approach tendencies measured after anger inductions are increased for individuals with greater left frontal asymmetry. To date, aggression in these studies has been operationalized as reported attitudes (Harmon-Jones, 2003b), choice of aversive tasting liquids (Harmon-Jones & Sigelman, 2001), signing petitions (Harmon-Jones et

al., 2003), and recommendations for hiring (Harmon-Jones & Peterson, 2008). It is difficult to determine from these laboratory approximations of aggression if interpersonal aggression (i.e., verbal or physical) would relate to approach cortical activity in the same way. The generalizability of these findings would be enhanced by using stimuli embedded in one of the most common contexts for interpersonal aggression: parent-child interactions.

Aggressive parenting and harsh discipline

Most parents of young children experience anger frequently and at high levels (e.g., Frude & Goss, 1979). Thus, it is a fitting context in which to study individual differences in approach sensitivity in anger-provoking situations. For example, parents discipline their toddler-aged children as frequently as every 6 to 9 minutes (Minton, Kagan, & Levine, 1979; Power & Chapieski, 1986). Dix, Reinhold, and Zambarano (1990) found that when mothers were angry, they made more negative evaluations of both their own children's and other children's behavior, believed more sternness would be needed to gain compliance, and evidenced more negative biases in their judgments about their children and the interaction. In another study, parents who reported a bad mood preceding children's misbehavior were more likely to use power-assertive discipline, compared with parents who were not previously in a bad mood, even when the children's misbehavior was considered accidental (Critchley & Sanson, 2006).

Parental actions during an angered state are more likely to be harsh or aggressive (Dix, 1991; Milner & Dopke, 1997). For example, greater parental anger was associated with more aggressive and less effective discipline strategies (e.g., Slep & O'Leary, 2007). Hill and colleagues found that greater maternal difficulty in anger modulation was strongly associated ($r = .40$) with observed problematic discipline (Hill, Maskowitz, Danis, & Wakschlag, 2008). It becomes more important to consider the link between anger and harsh parental discipline

because children who are disciplined harshly also tend to behave coercively and negatively, evoking anger and harshness from the parent in a negative escalating cycle (e.g., Patterson, 1982, 1990). This negative coercive cycle and harsh parental discipline have negative consequences for children's adjustment (e.g., Patterson, 1982; Regalado et al., 2004).

Generally, harsh verbal or physical discipline is ineffective and includes more hostility toward the child (e.g., Hill et al., 2008; Patterson, 1982). This style of discipline in response to perceived child misbehavior has been referred to as an overreactive discipline style (Arnold, O'Leary, Wolffe, & Acker, 1993). It is characterized by parents' displays of anger or irritation in response to children's misbehavior (e.g., Arnold & O'Leary, 1995; Lorber, O'Leary, & Kendziora, 2003). In asymmetry literature, the perceived ability to regain control or unblock one's thwarted goal is a necessary component in the link between anger and increased left relative to right cortical activity (e.g., Harmon-Jones, Bohlig, & Harmon-Jones, 2003). Parents' may feel angry if they perceive children to have more control than they do and subsequent behavior may be aimed at removing the perceived threat to control with power assertive techniques (i.e., the "paradoxical misuse of power," Bugental & Lewis, 1999, p. 51).

Frontal Asymmetry in the Parenting Context

In light of the literature reviewed in emotion processing and parenting, parental anger is expected to activate greater left frontal asymmetries due to its approach motivating properties. Further, greater parental anger in response to children's misbehavior is hypothesized to be associated with more aggressive discipline responses. Recorded brain activity has not been studied in relation to mothers' experience of anger to child misbehavior or their discipline responses. However, other physiological measures suggest that abusive mothers — who are, by definition, more aggressive in their parenting — experience higher levels of physiological

arousal than non-abusive mothers do in response to both infant distress and infant smiling, which might indicate that these mothers have stronger approach motivation tendencies that are not valence-dependent (Frodi & Lamb, 1980).

Current study

This study examined trait anger and overreactive parenting in mothers and its relationship to resting EEG asymmetry. In addition, an analogue parenting task was designed to induce anger in response to child misbehavior and state related changes to EEG asymmetry. Mothers were asked to watch a clip of children misbehaving and imagine themselves as the parent in the situation and then provide their parenting responses. Anger stimuli that are personally relevant produce stronger asymmetries (Harmon-Jones, Harmon-Jones, Abramson, & Peterson, 2009; Harmon-Jones, Lueck, & Fearn, 2006), thus asking mothers to “parent” was expected to be a highly personally relevant task.

In addition, when studying approach motivation, the opportunity to act or respond to the emotion (anger) evoking stimuli produces asymmetries more consistently than when individuals are angered and do not believe they can act to change the situation (Harmon-Jones, Bohlig, & Harmon-Jones, 2003). In their study, students listened to a radio broadcast arguing for a tuition increase and half believed they would have the chance to respond by petition to stop it while the other half believed the increase would occur no matter what their response. Students who believed they had the chance to petition against the tuition increase evidenced left frontal asymmetries; helpless students did not (Harmon-Jones et al., 2003). In the current study, mothers were told that they were going to be expected to provide their parenting response following the video clip to ensure their awareness of an opportunity to act.

The study hypotheses were as follows:

Hypothesis 1: Greater left frontal activity at baseline, dispositional (trait) anger, and harsh discipline style in mothers will be positively related.

Hypothesis 2: Greater dispositional (trait) anger will be related to state changes in alpha activity resulting in greater left frontal activity during an emotion-eliciting video of children misbehaving. Further, a more harsh discipline style will account for unique variance in state related left frontal activity.

Hypothesis 3: Greater left frontal activity at baseline will be predictive of greater reported anger and more harsh discipline responses from mothers following the emotion-eliciting video of children misbehaving. Greater state related left frontal activity will also be predictive of contextual anger and the level of aggression endorsed in the analogue parenting task.

In sum, motivational emotion processing and specifically approach motivation in relation to trait and state anger was hypothesized to be the relevant source of variance in asymmetrical activity. Individual differences in the intensity of experienced anger and EEG asymmetry were hypothesized, and tested with an ecologically valid parenting task that held constant the aversiveness of child misbehavior. Mothers' reported anger and asymmetrical frontal activity were hypothesized to be positively associated with aggressive or overreactive discipline.

Chapter 2

Method

Participants

A priori power analyses were conducted and used to achieve a sufficient sample size for the study objectives. Mothers from Long Island, New York and Miami, Florida were recruited from the community with flyers and researcher contact, as well as with a snowball technique (Goodman, 1961). It was believed that the non-random sample would not greatly affect the results because EEG activity is thought to be relatively stable and involuntary (e.g., Tomarken et al., 1992) and the scope of the study was normative parental emotions and discipline practices. Mothers were eligible to participate if they had at least one child between the ages of 2 and 4 years old, spoke English, reported being right-handed, and did not report a history of loss of consciousness for more than 10 minutes or epilepsy. Eighty mothers met eligibility criteria and expressed interest in being contacted to participate in the study. Of these, fifty-eight mothers of toddlers participated in the study. Complete data were obtained from 40 participating mothers. There were no significant differences found between the study variables for mothers with complete data compared to mothers with missing data; therefore, analyses included only mothers with complete data. Table 1 reports the demographic information for the resulting sample.

Procedure

Mothers came to the laboratory for approximately one hour to complete the protocol. After consenting to participate in the study, they completed a demographic questionnaire and self-report measures of parenting, and trait anger on the computer. Then they were fitted with the EEG cap (Electro-Cap, Eaton, OH) corresponding to the international 10–20 electrode system. Cap sizes were selected for participants based on measured head circumference. EEG was

recorded from 19 scalp sites (F7, F3, Fz, F4, F8, and FCz [frontal], C3, Cz, C4 [central], T7, T8 [anterior temporal], M1, M2 [Mastoids], P3, Pz, P4 [parietal], O1, O2 [occipital]), with a ground electrode at site AFz. EEG signals were referenced to Cz and eye movements (electro-oculograms, EOG) were recorded with electrode pairs placed at the supra- and sub-orbit of the right eye and at the external canthi of each eye. EEG signals and EOG signals were amplified by factors of 5000 and 2500, respectively, with the high-pass filter settings at 0.1 Hz and the low-pass filter settings at 100 Hz.

To obtain baseline measures of EEG, participants were asked to sit relaxed and as still as possible during 1-minute intervals with eyes open and closed for a total of 8 minutes, counterbalanced for order (e.g., Harmon-Jones & Allen, 2003). Following baseline EEG recordings, mothers were given instructions for the analogue parenting task. They were told to watch a short video clip of children misbehaving. Mothers were asked to watch the clip as if they were the parent of the children in the video and to think about how they would respond in order to provide their parenting response at the conclusion of the video clip. The video clip was a one-minute and 20-second montage of young children misbehaving in an escalating manner without adult intervention. Examples of the kinds of misbehavior portrayed included throwing objects, hitting siblings, and being physically aggressive toward playmates. Following the video, mothers were asked to think about what they would do in response to the child behavior they just watched for 30 seconds while EEG was still being recorded. After the EEG recording concluded, participants answered a series of Likert scale questions on the computer: (a) “How motivated would you be to act those situations?”; (b) “How likely would you be to use physical discipline?”; and (c) “When watching the video, to what degree did you feel angry/sad/happy?” All answer choices were presented on a 7-point Likert scale corresponding from least to most

emotive for the emotion questions and least to most aggressive for the discipline questions.

Finally, mothers were asked to provide their parenting response in an open-ended format written on the computer.

Measures

Parenting Scale. The Parenting Scale (PS; Arnold, O’Leary, Wolff, & Acker, 1993) is a brief rating scale designed to measure parenting effectiveness. This 30-item questionnaire introduces several reasons children typically misbehave. Then the instructions ask parents to think about their parenting in the past two months while answering questions about their behavior in different scenarios involving their child. Parents respond on a 7-point scale that is anchored on either extreme with the effective parenting response and the opposing ineffective response. For example, a scenario reads, “When I say my child can’t do something...” and the anchor points read, “I stick to what I said,” (effective response) and “I let my child do it anyway,” (ineffective response). In the original scoring of the measure, the three resulting scales were Overreactivity, Laxness, and Verbosity. The original measure reported reliability alpha as .84 for the total score and .80 for the Overreactive scale. Test-retest reliability has been reported as .82 (see Arnold et. al, 1993). More recent validity and factor analysis studies of the Parenting Scale suggest a three-factor model that reduces the number of items for each scale and replaces Verbosity with a Hostile parenting scale (Reitman, Rhoades, & O’Leary, 2007). This study used the reduced Overreactive scale and Hostile discipline scales. The five-item Overreactive (OVR) scale consists of items representing “nitpicking” or a lower threshold for misbehavior and allowing things to “build-up” or escalate (OVR possible range 5-35; Reitman et al., 2001; Rhoades & O’Leary, 2007). The Hostile (HOS) scale consists of three items representing harsh verbal or physical discipline practices (HOS possible range 3-21; Rhodes et al., 2007). After

reverse scoring some items, a higher score on the scales and total score indicate more ineffective parenting strategies. Reliability for the overall measure was $\alpha = .76$ in this study. See Table 2 for descriptive information for these scales and the correlations between all behavior variables for the study.

State Trait Anger Expression Inventory (STAXI-2). The STAXI-2 is a self-report measure designed to assess two main aspects of anger- the experience of anger and the expression of anger (Spielberger, 1999) within two contexts — situation (state) and disposition (trait). The STAXI-2 consists of 44 items distributed across three main scales: State Anger, Trait Anger, and Anger Expression. In addition scales have been constructed to measure Anger In, Anger Out, and Anger Control. All items are rated on a four-point scale and are assigned a score between 1 and 4 with higher scores reflecting greater anger for each of the scales except Anger Control; higher scores in the Anger Control scale reflect better control over one's anger and ability to calm down when upset. Trait Anger and the Anger Expression Index were used in this study as a measure of dispositional anger (see Table 2). Trait Anger is made up of 10 items that correspond to typical responses and thresholds for anger and scores can range from 10 to 40. The Anger Expression Index is a measure of overall frequency of anger expression whether it is outwardly expressed or inwardly directed. It is computed by adding the score from eight Anger In items to the score from eight Anger Out items with the score from eight Anger Control items subtracted and then adding 16 to the score to prevent a negative score. Scores for Anger Expression can range from 0 to 72. Convergent validity has been demonstrated with the Buss Durkee Hostility Scale and reported reliabilities are generally good, with alpha ranging from .75 to .91 (Spielberger, 1988).

Aggressive discipline. Following the viewing of the video clip of young children misbehaving, mothers answered two questions regarding aggressive discipline. Prior to viewing

the video, they were told to think about what they would do in as the parent, and to imagine it as if it were going to be the next scene in the video. After viewing the video, they were asked, “How motivated were you to act in those situations?” Responses were on a 7-point Likert scale anchored by 1 “not at all” and 7 “extremely.” The second question was, “How likely would you be to use physical discipline? Answer fall along a 7-point Likert scale anchored by 1 “absolutely not” and 7 “definitely.” Lastly, they were given the chance to explain what they would do as the parent; responses were typed by the participant on the computer. These answers were used for qualitative purposes only and were not included in further analyses. Responses to the strength of motivation to act and use of physical discipline were added together as a measure of discipline response (see Table 2). Higher scores correspond to more aggressive behavior in response to the child misbehavior.

Affective response to video clip. Following the viewing of the video clip and open-ended response, mothers were also asked the extent to which they felt the following emotions: “angry”, “sad”, and “happy” while watching the clip. Emotions were rated on a 7-point Likert scale with 1 indicating “not at all” and indicating 7 “extremely.” (See Table 2.)

EEG recording and processing (alpha power). As in previous research (Davidson, 1998; Harmon-Jones & Allen, 1997; Tomarken, Davidson, Wheeler, & Doss, 1992), the alpha band were used to quantify differences in hemispheric activity as measured by scalp-recordings of activation, and the power density values were log transformed to normalize the distributions as necessary. To process the EEG data for computing the frontal-asymmetry index, first all recordings were re-referenced offline to the average activity recorded from the left and right mastoid, sampled at a rate of 512 Hz, and filtered with a bandpass filter (0.1-100 Hz with a 60 Hz notch filter). The EEG was visually reviewed offline in order to identify and remove any

sources of artifact due to eye movements (ERP Analysis System, James Long Company). Then, artifact-free epochs of 2.048 seconds were extracted using a Hammingwindow in which contiguous epochs overlapped by 75%. This reduces data loss. A fast Fourier transform was used to calculate an average of the power spectra from which used the total power in the alpha range (8-13 Hz) at each electrode site. Some data were lost due to excessive artifact contamination and corrupted raw data files. The resulting sample size for analyses was $n = 40$.

At homologous sites in the left and right frontal areas, asymmetry indices were computed ($\log \text{right} - \log \text{left}$ alpha power divided by $\log \text{right} + \log \text{left}$ alpha power). Because alpha power is inversely related to activity (Lindsley & Wicke, 1974), higher scores on the index indicate greater left-hemisphere activity (lower left alpha power). We computed asymmetry indices for the following sites: F3/4 (superior), F7/8 (inferior) for frontal activity and P3/4 for a comparison site to speak to the specificity of frontal areas for emotion processing. For resting baseline, data were weighted to reflect the greater number of artifact free epochs in the eyes closed minutes and then averaged across eyes-open and eyes-closed minutes ($M = 389.19$ artifact-free epochs, $SD = 60.26$). For the analogue parenting task, there were an average of 85.65 artifact free epochs ($SD = 25.29$). Finally, a change score was also computed for asymmetrical activity, calculated as the difference between the baseline and state related indices. See Table 3 for descriptive information on asymmetry indices at each site for baseline and state related cortical activity.

Chapter 3

Results

The aims of this investigation were to test the motivational hypothesis of frontal cortical activity in the ecologically relevant context of parenting. Anger, parental discipline/aggression, and frontal asymmetries in EEG alpha activity were measured as trait and as contextual state variables. Results are organized by data preparation steps and then by each hypothesis.

To test the assumption that anger would be the primary emotion evoked in the analogue parenting task, we compared anger ratings following the video ($M = 4.05$, $SD = 2.08$) to ratings of sadness ($M = 3.63$, $SD = 2.11$), $t(39) = 1.47$, $p < .15$ and happiness ($M = 1.17$, $SD = .50$), $t(39) = 8.11$, $p < .001$. Because the difference between anger and sadness was not significantly different, correlations were run between sadness and the major study variables, with no significant findings. The study variables were normally distributed and no other transformations were made except to asymmetry indices as described above.

Hypothesis 1: Greater left frontal activity at baseline, dispositional (trait) anger, and harsh discipline style in mothers will be positively related.

Pearson correlations among trait anger, the anger expression index, overreactive discipline, hostile discipline, and asymmetry indices for superior, inferior and parietal cortical areas were run. As hypothesized, trait anger was positively correlated with overreactive discipline, $r(40) = .38$, $p = .02$. Anger expression was also positively correlated with overreactive discipline, $r(40) = .40$, $p = .01$ and hostile parenting, $r(40) = .32$, $p = .04$. However, baseline asymmetry indices were not significantly correlated to self-reported trait anger, anger expression, or harsh parenting (anger expression and superior frontal asymmetry index F3/4 were the most closely related; $r(40) = .23$, $p = .17$, *ns*). As an exploratory step, we also tested the

Anger In, Anger Out, and Anger Control subscales of the STAXI-2 for correlation with baseline asymmetry with no significant relationships found.

Hypothesis 2: Greater trait anger will be related to state changes resulting in greater left frontal activity following an emotion-eliciting video of children misbehaving. Further, a more harsh discipline style will account for unique variance in left frontal activity.

Trait anger was found to be positively correlated to state related changes in frontal asymmetry, such that greater reported trait anger was related to greater left frontal activity during the analogue parenting task, $r(40) = .35, p = .03$. A simple regression model with trait anger as the predictor and state related frontal asymmetry ($F_{3/4}$) as the outcome variable was significant, $F(1, 38) = 6.71, p = .01$ and accounted for 15% of the total variance. Then, to test for the unique contribution of trait anger and harsh discipline style on left frontal activity, a regression model was tested, with trait anger and overreactive discipline entered simultaneously to predict state changes in frontal activity. The overall model was significant, $F(2, 37) = 4.37, p = .02$ and accounted for 19.1% of the variance, more than trait anger alone; however when entered stepwise, the change in variance explained when overreactive discipline was added to the model was not significant ($\Delta R^2 = .04, p = .18, ns$). (See Table 4 for a summary of regression analyses).

Hypothesis 3: Greater left frontal activity at baseline will be predictive of greater reported anger and more harsh discipline responses from mothers following the emotion-eliciting video of children misbehaving. Left frontal activity in the negative state condition will also be predictive of contextual anger and harsh discipline.

Baseline asymmetry indices were not correlated with reported anger evoked by the analogue parenting task or the aggressiveness of discipline responses on this task. Therefore, planned hierarchical models including baseline asymmetry indices as the first step were not

tested. Mother's reported anger and discipline response to the analogue parenting video were not correlated to state related asymmetry indices.

A series of additional analyses were conducted to test the validity of the analogue parenting task in eliciting meaningful parenting responses from mothers, correlations between mothers' self reported discipline on the Parenting Scale (OVR and HOS) and their discipline response in the analogue parenting task. Aggressiveness of mothers' responses to the videotaped misbehavior was significantly related to self-reported overreactive ($r(40) = .41, p = .009$) in the expected positive direction. In addition, the aggressiveness of mothers' discipline responses were significantly positively related anger ratings during the video to ($r(40) = .49, p = .001$), and significantly negatively related to happiness ratings during the video ($r(40) = -.35, p = .03$) suggesting that although the misbehavior video did not correspond to greater left frontal activity during the video, it did elicit behavior responses of anger and harsher parental discipline consistent with expected relationships.

The magnitude of change between baseline and state activation may also be an important marker of individual differences in approach motivation. This relationship between the change index, and parenting responses from mothers, correlations between mothers' self reported discipline on the Parenting Scale (OVR and HOS) and their discipline response in the analogue parenting task were explored with Pearson correlations. Similar to what was found with the state asymmetry index, the only significant relationship was between change in asymmetry and trait anger ($r(40) = .33, p = .04$). A simple regression model with trait anger as the predictor and the change index for asymmetry ($F(3/4)$) as the outcome variable was significant, $F(1, 38) = 4.48, p = .04$ and accounted for 11% of the total variance.

Chapter 4

Discussion

This study set out to better understand the processes linking anger and harsh parental discipline using innovative theory and methodology from affective neuroscience. The parent child relationship is a context that has not been used in previous studies interested in frontal asymmetry and emotion processing. Parenting theories and motivation theories of emotion processing converge in this study with evidence that trait anger is related to mothers' discipline responses as well as their approach related cortical activity. Learning about how anger affects mothers' patterns of cortical activity in a discipline context has important implications for the way we approach parenting intervention in clinical settings.

The motivation theory of emotion processing posits that observed asymmetrical activity in the left and right frontal areas of the brain is indicative of an individual's motivation to approach or avoid emotional stimuli. Emotional stimuli that prompt more motivation to approach produce greater activity in the left frontal region as compared to the right. A growing body of work suggests that this theory finds more support than earlier theories aligning asymmetry activity with the valence (e.g., positive or negative; Heller, 1990) of emotional stimuli using anger as the stimulus. Anger is a negative emotion with approach motivating properties and is associated with greater left versus right frontal asymmetry. Previous studies have found that in anger evoking situations, left frontal asymmetries are more active in individuals with greater trait anger, suggesting they have a sensitivity to anger related approach activation (Harmon-Jones, 2007).

We were able to replicate previous findings in the field of affective neuroscience using theoretically relevant variables from the parenting literature; individuals with greater trait anger

evidence greater left frontal activity in anger evoking contexts. In addition, the magnitude of change from baseline to the anger evoking context was predicted by mothers' trait anger.

Mothers in this study who first reported higher levels of trait anger later had greater activation in the left superior frontal region when asked to be the parent in a misbehavior context. They also had greater changes in alpha activity in the left frontal area from baseline to the misbehavior context. Thus, this study lends further support to the motivational theory of emotion processing in asymmetrical frontal activity, and specifically the approach motivating properties of anger (e.g., Harmon-Jones, 2007; Harmon-Jones & Sigelman, 2001).

When there is high negative affect such as anger present, conflict and coercive exchanges between parents and children are less likely to end constructively (e.g., Gottman, 1991; Snyder & Patterson, 1995). Fitting with the coercive family process model, an approach sensitive parent likely has a lower threshold and impetus to act in response to their children's perceived misbehavior creating more opportunities for negative reciprocal reinforcement and strengthening of the coercive cycle. In this study, mothers with greater trait anger (a) endorsed more harsh and overreactive discipline strategies (b) evidenced greater left frontal activation when confronted with an analogue parenting task involving child misbehavior and (c) had greater changes from baseline asymmetry in the analogue parenting task. Further, mothers who endorsed more harsh and overreactive discipline strategies also responded more aggressively in the analogue parenting task.

Indeed, there seems to be a cluster of constructs in parenting literature that are associated with less favorable outcomes for the parent child relationship and child behavior. An authoritarian parenting style, more hostile attributions, greater trait anger, greater contextual anger, and now, approach related left frontal asymmetry in response to misbehavior are

associated with less effective, more aggressive discipline responses from mothers. More broadly, it can be argued these response styles and negative emotions motivate approach related behaviors. For example, according to Baumrind (1971) and Maccoby (1992) very demanding authoritarian parents have more expectations for their children (and therefore more opportunities to be thwarted), and also discipline their children more harshly and frequently. Authoritarian parents have been found to respond differently than authoritative parents to child misbehavior, reporting increased anger and hostile attributions, across different child rearing contexts.

Because there were no relationships found between baseline frontal asymmetry in mothers and the other study variables, we cannot speculate on the role of more stable patterns of activation found in other asymmetry studies in experimental and less applied contexts. However, this study is an impetus to explore more of the conditions and qualifiers of the motivation theory of emotion processing in the frontal regions as it relates to more complex interpersonal and real life scenarios. For example, in reliability studies of frontal EEG asymmetry, state activated activity has been found to be more stable across time compared to trait asymmetry estimates (e.g., Coan & Allen, 2004). This may be due to occasion specific factors in baseline recordings such as momentary mood, and cognitive activity that is not measured while the person is letting their mind wander under the instruction to *sit quietly while baseline data is recorded* (e.g., Coan, Allen, & Nazarian, 2004; Harmon Jones, Gable, & Peterson, 2010).

Another possibility is that resting EEG is not a precise measure of the motivation system in an emotion inducing context because our brains do not operate in static systems, but rather they adapt and react depending on the demands arising from the environment. Other researchers are beginning to find evidence that suggests there is a stronger relationship between activity during emotional manipulation and behavioral variables compared to resting activity (e.g., Coan, Allen,

& McKnight, 2006). This is not to say that stable individual differences in motivation systems in the brain do not exist; however, they may be found in the magnitude of change or in frontal asymmetry during emotional challenges instead of at rest. In short, resting data is less constrained by the manipulations and control of the study, is less reliable in its relationship to emotions and behavior responses (e.g., Coan et al., 2006; Coan & Allen, 2004) and individual differences in activation or magnitude of change from baseline to manipulation may be a fertile area of future study of the motivation hypothesis of frontal activity as the field moves toward applied contexts.

Clinical Implications

The clinical utility of parenting intervention and assessment informed by approach motivation sensitivity is supported by this study. Applying asymmetry findings to a biopsychosocial model of case conceptualization could hold several potential benefits. First, explanations that include individual differences in approach motivation may help frustrated parents re-attribute their difficulties as partly biologically-based, rather than due to bad children or bad parenting. Including this information in case conceptualization also validates what many parents report: namely, that it is difficult to control anger reactions, and that their acts are contrary to what they know they *should* do.

Clinicians need not have EEG equipment to identify individual differences in approach motivations; self-report measures of BAS/BIS can assess individuals' approach and inhibition tendencies. Individuals with BAS sensitivity are more aggressive in their responses to provocation, even more so if approach motivation is primed (Harmon-Jones & Peterson, 2008). "Priming" in parent-child contexts may be the coercive interaction pattern history that escalates into aggressive incidents more and more quickly as it self-perpetuates (e.g., Patterson, 1982).

Incorporating BAS/BIS information into assessment of parents presenting for therapy may help identify parents at higher risk for aggression in situations when they are angered by their children. This information would not only inform case conceptualization and remove some of the blame from parents, it would also create a rationale for directly addressing anger's role in parenting contexts and ways to reduce its impact on parents' behaviors.

For example, when parents are identified either as having a child with behavior problems or maladaptive discipline responses, many empirically supported parenting programs successfully teach parents to respond more appropriately, more consistently, and to notice and reward good behavior (e.g., Parent Child Interaction Therapy in Chaffin et al., 2004; Triple P in Sanders & McFarland, 2000). In doing this, parents are thought to be changing the coercive process by giving the children less negative reinforcement for misbehavior and more positive reinforcement for desired behaviors (e.g., Patterson, 1982). However, these parental behavior changes require inhibition of previous parenting techniques that are often over-learned, and primed by history of interactions with the misbehaving child, presenting an extra challenge for a parent with greater approach tendencies. For example, it may be harder for approach sensitive parents to ignore their children's minor misbehavior because they are more readily angered, and ignoring could be perceived as doing nothing, which is in opposition to the impetus to act.

The addition of interventions targeting approach sensitivities to existing parenting programs may increase treatment efficacy for more parents. For example, biofeedback studies show preliminary evidence that people can learn to increase cortical activity in either hemisphere. Further, the use biofeedback to increase right frontal activity or reduce left frontal activity has been shown to produce changes in emotional responses and could help inhibit sensitivities to approach related anger (e.g., Allen et al., 2001).

Another study by Harmon-Jones (2006) found that simple contralateral contractions of hand or leg muscles could engage the right frontal areas of the brain. Parents may be able to do these contralateral contractions to help increase inhibition when they begin to feel angry. The incorporation of mindfulness (e.g., Kabat-Zinn, 1994) could facilitate other cognitive processes that temper actions originally fueled by emotion.

Parents may find it easier to commit to these smaller, actively engaging interventions (e.g., muscle contractions) in stressful situations rather than follow instructions to “ignore” or “stay calm” (e.g., parent training goals in the face of attention seeking misbehavior). Working within the parameters of an individual’s current emotional processing tendencies to change behavior may be intervening on the path of least resistance. Although these techniques are not grounded in parenting literature, empirical findings suggest they employ the same mechanism underlying frontal asymmetry (e.g., Allen et al., 2001; Harmon-Jones, 2006) and therefore could help reduce anger or its motivational properties in the parenting context as more effective parenting skills are learned

Limitations

This study had several limitations worth considering when discussing the results and future directions for this line of research. First, there was a great deal of data lost due to differences in EEG recording equipment that could introduce error, excessive artifacts in the raw data, and human error in data collection that made up to 30% of the EEG data unusable. Tests comparing those with complete data to those without complete data confirmed that data were missing at random, so the overall sample size was reduced by listwise deletion of cases. However, non-significant results were likely not affected by power because the effect sizes obtained were very small and not approaching significance. Second, participants were recruited

in a snowball method, yielding a relatively homogenous sample of mothers from a middle class, primarily Hispanic population in Miami, Florida. It could be that the limited range of some variables and the non-representative, homogenous sample obscured the relationship between baseline frontal asymmetry and other variables. The behavioral measures were all grossly normal in distribution but the range was somewhat restricted for some variables. For example, the majority of mothers answered that they were “extremely” motivated to act in response to the misbehavior video. Although this suggests a successful stimulus video for the parenting task, it reduced variability in the composite aggressiveness of response score. Further, mothers’ reports of discipline and anger variables were both normally distributed and in the normal, non-clinical range, which is to be expected given the community sample obtained. Perhaps with a broader sample of mothers with less effective discipline practices would clarify the relationship between behavioral and EEG data. The failure to replicate previous research linking baseline frontal asymmetry to trait measures of emotion and state related frontal asymmetry could be viewed as either a limitation of this study because the stability of resting asymmetric cortical activity has been well replicated, or a limitation of the application of resting asymmetry to applied contexts (e.g., Tomarken et al., 1992). It should be noted that not all studies find a relationship between self-reports of mood and resting frontal asymmetries, possibly because mood reports are not sensitive or the range in mood inductions is restricted (e.g., Hagemann, 2004; Reid, Duke, & Allen, 1998). Also, methodological papers in psychophysiology suggest that in order to obtain a reliable trait or baseline asymmetry index, one should average multiple EEG recordings across several sessions (e.g., Allen, Coan, & Nazarian, 2004; Wheeler et al., 1993). This study only used a single recording session in its baseline asymmetry calculations, which could have yielded more variable estimates.

Future Directions

This study is only the first step in translating work in basic emotion processes in approach sensitivity into clinically useful information for anger and aggression in parenting. It would be useful to test hypotheses about resting and active asymmetric frontal activity in a sample including a referred sample such as mothers who have physically abused their children to give insight into the functioning of the motivational-direction system in the frontal cortex when behaviors and emotions are in the clinical range. In addition, it is likely that there are cognitive variables that moderate the relationship between emotions and action tendencies, and possibly the pattern of cortical activation in the frontal areas. Harmon-Jones (2003) added induced empathy as a possible moderator of anger-evoked approach. Although participants in the insult condition still reported more anger, those in the high empathy condition had less cortical activation in the left frontal region and had less hostile attitudes toward the other participant. Sympathy has also been found to attenuate the relationship between anger and increased left cortical activity (Harmon-Jones, Vaughn-Scott, Mohr, Sigelman, & Harmon-Jones, 2004). Finally, further translational work should include tests of the applications suggested herein for their clinical utility and incremental improvement in existing parenting interventions.

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Appendix A: Tables

Table 1
Participant Demographics

Variable	Statistic
Child Age	3.10 (1.02)
Child Gender	
Male	20 (50%)
Female	20 (50%)
Mother Age	33.83 (4.63)
Ethnicity	
Hispanic	27 (68%)
Other	13 (32%)

N = 40

Table 2
Correlations Among Behavioral and EEG Variables

Measure	1	2	3	4	5	6	7	8	9	10	Mean (SD)	Range
STAXI												
1. Trait Anger	--										16.25 (3.84)	10-26
2. Anger Expression Index	.54***	--									20.63 (8.24)	7-44
Parenting Scale												
3. Overreactive Parenting	.38*	.40**	--								14.83 (4.71)	5-24
4. Hostile Discipline	.28	.32*	.49***	--							4.43 (2.02)	3-10
5. Aggression to video	-.08	.05	.41**	.29*	--						9.73 (2.28)	6-14
Emotion Response to Video												
6. Angry	.14	.01	.13	.01	.49***	--					4.05 (2.08)	1-7
7. Happy	.04	.14	-.13	-.14	-.35*	-.36*	--				1.15 (0.43)	1-3
8. Sad	.27	.08	.15	.24	.29	.62***	-.28	--			3.63 (2.11)	1-7
EEG Asymmetry												
9. State Midfrontal Asymmetry F 3/4	.39*	.35*	-.03	.01	-.20	.02	.00	.27	--		0.06 (0.10)	-.19, .33
10. Change in Midfrontal Asymmetry F 3/4	.33*	.13	.02	.02	-.15	.04	.00	.32	.73***	--	0.02 (0.12)	-.19, .35

*p < .05, **p < .01, ***p < .001

Table 3
 Descriptive Information for Asymmetry Indices

Asymmetry Index	Mean (SD)	Range
Baseline (Weighted average eyes open and closed)		
Superior Frontal F3/4	.039 (.086)	(-.31, .18)
Inferior Frontal F7/8	.073 (.121)	(-.15, .29)
Parietal P3/4	-.009 (.164)	(-.33, .40)
State Related (Misbehavior Video)		
Superior Frontal F3/4	.063 (.099)	(-.19, .35)
Inferior Frontal F7/8	.106 (.209)	(-.28, .61)
Parietal P3/4	-.009 (.339)	(-1.76, .36)

Table 4
 Summary of Regression Analysis for Variables Predicting State Asymmetric Frontal Activity

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Trait Anger	.01	.004	.387**	.01	.004	.470***
OVR				-.005	.003	-.218
R^2		.15			.19	
<i>F</i> for change in R^2		6.71**			1.87	

p < .01, * p < .001